PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference GRA26 007 PC	**FOR FURTHER ACTION**	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/US03/32585	International filing date *(day/month/year)* 16 October 2003 (16.10.2003)	Priority date *(day/month/year)* 16 October 2003 (16.10.2003) * IB
International Patent Classification (IPC) or national classification and IPC IPC(7): H04B 17/00 and US Cl.: 455/67.13, 562.1, 19, 20, 21, 22, 25, 24, 66.1, 69, 67.11, 65, 63.4, 82, 83, 277.1, 277.2		
Applicant ANDREW CORPORATION		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 6 sheets, including this cover sheet.

   ☐ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of _____ sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of report with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
12 May 2004 (12.05.2004)	09 December 2004 (09.12.2004)
Name and mailing address of the IPEA/US Mail Stop PCT, Attn: IPEA/US Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450 Facsimile No. (703)305-3230	Authorized officer John J. LEE Telephone No. 703-306-5936

Form PCT/IPEA/409 (cover sheet)(July 1998)

INTERNATIONAL PRELIMINARY [redacted]INATION REPORT

International application No.
PCT/US03/32585 [redacted]

I. Basis of the report

1. With regard to the elements of the international application:*

☒ the international application as originally filed.

☒ the description:
pages 1-12 as originally filed
pages NONE , filed with the demand
pages NONE , filed with the letter of _____.

☒ the claims:
pages 13-17 , as originally filed
pages NONE , as amended (together with any statement) under Article 19
pages NONE , filed with the demand
pages NONE , filed with the letter of

☒ the drawings:
pages 1-4 , as originally filed
pages NONE , filed with the demand
pages NONE , filed with the letter of _____.

☐ the sequence listing part of the description:
pages NONE , as originally filed
pages NONE , filed with the demand
pages NONE , filed with the letter of _____.

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.
These elements were available or furnished to this Authority in the following language _____ which is:

☐ the language of a translation furnished for the purposes of international search (under Rule23.1(b)).

☐ the language of publication of the international application (under Rule 48.3(b)).

☐ the language of the translation furnished for the purposes of international preliminary examination(under Rules 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

☐ contained in the international application in printed form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☒ The amendments have resulted in the cancellation of:

☒ the description, pages NONE

☒ the claims, Nos. NONE

☒ the drawings, sheets/~~fig~~ NONE

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).**

** Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).*

*** Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.*

INTERNATIONAL PRELIMINARY [redacted]INATION REPORT

International application No.
PCT/US03/32585 [redacted]

V. Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. STATEMENT

Novelty (N)	Claims 1-19	YES
	Claims NONE	NO
Inventive Step (IS)	Claims NONE	YES
	Claims 1-19	NO
Industrial Applicability (IA)	Claims 1-19	YES
	Claims NONE	NO

2. CITATIONS AND EXPLANATIONS
Please See Continuation Sheet

Supplemental Box
(To be used when the space in any of the preceding boxes is not sufficient)

V. 2. Citations and Explanations:

Response to Arguments

The applicant argues that the combination of Raleigh et al. (Raleigh, US Patent No. 6,144,711) and Motoyasu et al. (Motoyasu, Japanese Patent Application No. 05-135996) do not teach the claimed invention "resolving the covariance matrix a fictitious antenna array manifold". The examiner respectfully disagrees with the applicant's assertion. Contrary to applicant's assertion, Motoyasu teaches [known antenna array] manifold (paragraphs 0025 and 0029), and as a method improved so that bearing of an interference wave including such a coherent signal might be decomposed and bearing could be presumed correctly and also array antennas are made into a regular-intervals linear array, application in the case a coherent signal is included is enabled (see paragraphs 0025 and 0029), regarding the limitation [the improvement comprising the step of resolving the covariance matrix with a fictitious antenna array manifold], the motivation to achieve interference reduction in antenna system. Furthermore, the limitation "resolving the covariance matrix" is not require/limit to interpret for any specific detail in the claims.

Claims 1 -8, 10 -16, 18, and 19 lack an inventive step under PCT Article 33(3) as being obvious over Raleigh et al. (Raleigh, US Patent No. 6,144,711) in view of Motoyasu et al. (Motoyasu, Japanese Patent Application No. 05-135996).

Regarding claim 1, Raleigh teaches of in a method for estimating the multi-path delays in a signal received at an antenna array of k antenna elements (column 2, lines 59 -63), comprising estimating an impulse response at each k antenna, generating a space-time impulse response (column 12, lines 2 -16), forming a covariance matrix and resolving the covariance matrix with a known antenna array (column 21, lines 20 -31), the improvement comprising the step of resolving the covariance matrix with a fictitious antenna array (column 21, lines 55 -62).

Raleigh does not specifically teach of [known antenna array] manifold, [the improvement comprising the step of resolving the covariance matrix with a fictitious antenna array] manifold (note that brackets are used for clarity in language and that it is believed these limitations are addressed by the above cited reference).

In a related art dealing with multi-path mitigation, Motoyasu teaches of [known antenna array] manifold (paragraphs 0025 and 0029), [the improvement comprising the step of resolving the covariance matrix with a fictitious antenna array] manifold (paragraphs 0025 and 0029).

It would have been obvious to one skilled in the art at the time of invention to have included into Raleigh's signal processing system, Motoyasu's measuring concepts, for the purposes of interference reduction (brought about from radio multi-paths) as taught by Motoyasu.

Regarding claims 2 and 18, Raleigh teaches of a method and system for estimating the multi-path delays t in a signal using a spatially blind antenna array (column 2, lines 59 -63) comprising k arbitrary antenna elements (Figure 6 and column 11, lines 44 -53), comprising the steps of generating an impulse response hk for each antenna element k in the antenna array (Figure 6 and column 11, lines 44 -53 and column 12, lines 2 -16); determining a vectorized space-time impulse response I over the antenna array (column 13,

Supplemental Box
(To be used when the space in any of the preceding boxes is not sufficient)

lines 2 -22); creating a covariance matrix C (column 21, lines 21 -33); creating a fictitious array Af, wherein Af is spatially blind and independent of the array characteristics (column 21, lines 21 -33 and column 30, lines 30 -39); and resolving the covariance matrix C with the fictitious Af to thereby estimate the multi-path delays t independent of the array characteristics (column 21, lines 55 -65 and column 22, lines 3 -16).

Raleigh does not specifically teach of [creating a fictitious array] manifold [Af] and [resolving the covariance matrix C with the fictitious] manifold [Af] (note that brackets are used for clarity in language and that it is believed these limitations are addressed by the above cited reference).

In a related art dealing with multi-path mitigation, Motoyasu teaches of [creating a fictitious array] manifold [Af] (paragraphs 0025 and 0029) and [resolving the covariance matrix C with the fictitious] manifold [Af] (paragraphs 0025 and 0029).

It would have been obvious to one skilled in the art at the time of invention to have included into Raleigh's signal processing system, Motoyasu's measuring concepts, for the purposes of interference reduction (brought about from radio multi-paths) as taught by Motoyasu.

Regarding claim 3, Raleigh in view of Motoyasu teach all the claimed limitations as recited in claim 2. Raleigh further teaches of wherein the impulse response estimate hk is determined from the equation: hk = (ZZ^H)- Zrk where Z is a delay matrix and rk is the column vector of the received signal at antenna element k of the antenna array, where k=1,2,...m (column 19, lines 55 -59 and column 20, lines 6 -22).

Regarding claim 4, Raleigh in view of Motoyasu teach all the claimed limitations as recited in claim 3. Raleigh further teaches of wherein the space-time impulse response vector I is formed by stacking the individual impulse response estimates ht into a column vector (column 13, lines 6 -15).

Regarding claim 5, Raleigh in view of Motoyasu teach all the claimed limitations as recited in claim 2. Raleigh further teaches wherein the fictitious manifold Af is the aggregate of all vectors: a = [a1 a2 ... . Am] where ak (k=1,2,... m) range over the set of complex numbers, where m is the am number of antenna elements in the array (column 13, lines 6 -15 and column 16, lines 36 -46).

Regarding claim 6, Raleigh in view of Motoyasu teach all the claimed limitations as recited in claim 2. Raleigh further teaches wherein the covariance matrix C is generated according to the following equation: C={summation}II^H (column 21, lines 50 -62) .

Regarding claim 7, Raleigh in view of Motoyasu teach all the claimed limitations as recited in claim 2. Raleigh further teaches wherein the fictitious array manifold Afis used to form the space-time manifold and the space-time manifold operates to resolve the multi-path delays (column 22, lines 16 - 34).

Regarding claim 8, Raleigh in view of Motoyasu teach all the claimed limitations as recited in claim 2. Motoyasu further teaches of wherein the step of resolving the covariance matrix C to determine multi-path delays t uses the method of Multiple Signal Classification (MUSIC) techniques (paragraph 0030).

Regarding claim 10, Raleigh teaches of a method of estimating the multi-path delays t of a sequence of j blocks of a signal received at an antenna array of k isotropic antenna elements, independently of the spatial array characteristics of the antenna array (column 2, lines 59 -63 and column 13, lines 5 -22), comprising the steps of deriving channel impulse response estimates hj,k for each block j at each antenna k, determining a vectorized aggregate space-time impulse response I for each block j (Figure 6 and column 11, lines 44 -53 and column 12, lines 2 -16); forming an estimated covariance matrix for the sequence of j blocks (column 21, lines 21 -33); providing an array Af void of spatial information (column 21, lines 21 -33 and column 30, lines 30 -39); and, resolving the covariance matrix with the array manifold Af to determine the multi-path delays t (column 21, lines 55 -65 and column 22, lines 3 -16).

Raleigh does not specifically teach of [providing an array] manifold [void of spatial information] (note that brackets are used for clarity in language and that it is believed these limitations are addressed by the above cited reference).

In a related art dealing with multi-path mitigation, Motoyasu teaches of of [providing an array] manifold [void of spatial information] (paragraphs 0025 and 0029).

It would have been obvious to one skilled in the art at the time of invention to have included into Raleigh's signal processing system, Motoyasu's measuring concepts, for the purposes of interference reduction (brought about from radio multi-paths) as taught by Motoyasu.

Regarding claim 11, Raleigh in view of Motoyasu teach all the claimed limitations as recited in claim 10. Raleigh further teaches of wherein the impulse response estimate hj,k for block j is determined from the equation: h= (ZZ^H)^-1rj,k where Zj is a delay matrix for block j and rjk is the column vector of the received signal for block j at antenna k of the antenna array, where k=1,2,...m (column 19, lines 55 -59 and column 20, lines 6 -22).

Regarding claim 12, Raleigh in view of Motoyasu teach all the claimed limitations as recited in claim 11.
Raleigh further teaches of wherein the space-time impulse response vector I is formed by stacking the individual impulse response estimates hjk into a column vector (column 13, lines 6 -15).

Regarding claim 13, Raleigh in view of Motoyasu teach all the claimed limitations as recited in claim 10. Raleigh further teaches wherein the fictitious manifold Af is the aggregate of all vectors: a = [a1 a2 ... . Am] where ak (k=1,2,... m) range over the set of complex numbers, where m is the am number of antenna elements in the array (column 13, lines 6 -15 and column 16, lines 36 -46).

Regarding claim 14, Raleigh in view of Motoyasu teach all the claimed limitations as recited in claim 10. Raleigh further

Supplemental Box
(To be used when the space in any of the preceding boxes is not sufficient)

teaches wherein the covariance matrix C is generated according to the following equation: C={summation}IjIk^H (column 21, lines 50 -62).

Regarding claims 15 and 19, Raleigh in view of Motoyasu teach all the claimed limitations as recited in claims 10 and 18. Raleigh further teaches wherein the fictitious array manifold Afis used to form the space-time manifold and the space-time manifold operates to resolve the multi-path delays (column 22, lines 16 - 34).

Regarding claim 16, Raleigh in view of Motoyasu teach all the claimed limitations as recited in claim 10. Motoyasu further teaches of wherein the step of resolving the covariance matrix C to determine multi-path delays t uses the method of Multiple Signal Classification (MUSIC) techniques (paragraph 0030).

Claims 9 and 17 lack an inventive step under PCT Article 33(3) as being obvious over Raleigh et al. (Raleigh, US Patent No. 6,144,711) in view of Motoyasu et al. (Motoyasu, Japanese Patent Application No. 05-135996) and in further view of Madurasinghe (IEEE Electronics Letters).

Regarding claims 9 and 17, Raleigh in view of Motoyasu teach all the claimed limitations as recited in claims 2 and 10. Motoyasu further teaches of wherein the step of resolving the covariance matrix C to determine multi-path delays t (paragraph 0030).

Raleigh in view of Motoyasu do not specifically teach of uses the Method of Alternating Projection (APM).

In a related art dealing with multipathed radio waves, Madurasinghe teaches of uses the Method of Alternating Projection (APM) (page 1326 columns 1 and 2- Introduction).

It would have been obvious to one skilled in the art at the time of invention to have included into Raleigh and Motoyasu's signal processing system, Madurasinghe's alternating projection method, for the purposes of optimization of values (superior conventional methods), as taught by Madurasinghe.

---------- NEW CITATIONS ----------
NONE